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SPACE LAUNCH SYSTEMS PLAN (SLSP) EXPLORATION MISSION -1 SECONDARY PAYLOAD SAFETY REVIEW PROCESS

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HISTORY PAGE

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Baseline	–		Initial Baseline of SLS-PLAN-217, SLSP Exploration Mission-1 Secondary Payload Safety Review Process, per PCBD SV2-01-0210, dated March 19, 2015; CR SLS-00353; PCN SV00757	03/19/15

NOTE: Updates to this document, as released by numbered changes (Change XXX), are identified by a black bar on the right margin.

TABLE OF CONTENTS

PARAGRAPH **PAGE**

1.0 INTRODUCTION 6
1.1 Purpose 6
1.2 Scope 6
1.3 Change Authority/Responsibility 7
2.0 DOCUMENTS 8
2.1 Applicable 8
2.2 Reference Documents 8
3.0 ORGANIZATONAL ROLES AND RESPONSIBILITIES 10
3.1 Payload Developer 10
3.2 SLS EM-1 Payload Safety Review Panel (PSRP) 10
3.3 SLS Program 11
3.4 SLS PSRP Chairperson 11
3.5 SLS Engineering 11
3.6 SLS SMA 12
3.7 Spacecraft and Payload Integration/Evolution Office 12
3.8 Payload Safety Engineer (PSE) 12
3.9 PSRP Secretariat 12
3.10 GSDO/GSRP 12
3.11 Marshall Space Flight Center (MSFC) Flight Programs and Partnerships Office 13
3.12 ESD SMA 13
4.0 SAFETY REVIEW PROCESS 14
4.1 Safety Meeting Logistics 16
4.1.1 Meeting Types 16
4.1.2 Phased Safety Review Meeting Agenda 17
4.1.3 Data Submittal 18
4.1.4 Meeting Scheduling 18
4.2 Hardware Categories 18

4.2.1 Hazard Report Format 19
4.3 Phase Specific Information 19
4.3.1 Phase 0 Technical Interchange Meeting (TIM) 20
4.3.2 Phase I PSRP Review 20
4.3.3 Phase II PSRP Review 22
4.3.4 Phase III PSRP Review 23
4.3.5 Post Phase III Activities 26
5.0 PSRP SAFETY ENDORSEMENT 28
6.0 HAZARD ANALYSIS 29
6.1 Phased Hazard Report Development 29
6.2 Hazard Ranking 29
7.0 HAZARD APPROVAL PROCESS 30
8.0 WAIVERS 32
9.0 CERTIFICATE OF FLIGHT READINESS (COFR) 34
10.0 RECORDS RETENTION 35

APPENDIX

APPENDIX A ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS 36
APPENDIX B OPEN WORK 39
APPENDIX C PHASE I TECHNICAL DATA SUBMITTAL 40
APPENDIX D PHASE II TECHNICAL DATA SUBMITTAL 44
APPENDIX E PHASE III TECHNICAL DATA SUBMITTAL 49
APPENDIX F STANDARDIZED HAZARD CONTROL REPORT FORMAT 53
APPENDIX G UNIQUE HAZARD CONTROL REPORT FORMAT 60
APPENDIX H SLS EM-1 PSRP CERTIFICATE OF ENDORSEMENT 68
APPENDIX I SVTL FORMAT AND INSTRUCTIONS 69

APPENDIX J PAYLOAD DEVELOPER CERTIFICATE OF COMPLIANCE 71

TABLE

TABLE 4-1 PAYLOAD CATEGORIES 19

TABLE 4-2. PHASE III RECOMMENDATIONS 25

TABLE 4-3. SAFETY REVIEW RECOMMENDATIONS 26

TABLE B1-1. TO BE DETERMINED ITEMS 39

FIGURE

FIGURE 4-1. SLS PAYLOAD SAFETY PROCESS 15

FIGURE 7-1. HAZARD REPORT APPROVAL FLOW 31

FIGURE 8-1. WAIVER PROCESS 33

FIGURE 9-1. COFR PROCESS 34

1.0 INTRODUCTION

1.1 Purpose

This document defines the safety review process for SLS Exploration Mission 1 (EM-1) secondary payloads. The SLS EM-1 Payload Safety Review Panel (PSRP) panel will execute this process for SLS EM-1 secondary payload flight hardware design and operations. All ground hazards will be presented to GSDO for review and approval per the requirements of (**TBD-001)**. The PSRP will ass ground operations and associated hazards in parallel with the GSDO review to determine whether ground processing activities could result in hazard that manifest themselves during SLS prelaunch or flight operations The flight and ground safety review panels strive to address SLS EM-1 secondary payload safety review responsibilities as part of an integrated process that covers all aspects of the payload project's life cycle, per NPR 7123.1A and NPR 8715.3C. This document also accomplishes the following:

- Defines the safety reviews necessary to comply with the system safety requirements that are applicable to SLS EM-1 secondary payload flight hardware design and flight operations.
- Identifies the required content of the Safety Data Package (SDP).
- Describes preparation for and conduct of the safety review.
- Establishes the timeline for data submittal and establishes the depth of detail required for the various submittals.
- Defines the serial safety review process.

Hazards posed by payloads to SLS or Orion that meet the definition of ESD integrated hazards will be addressed in ESD integrated hazard record as defined in ESD 10010, Cross Program SMA Plan.

1.2 Scope

The SLS EM-1 safety review process applies to SLS EM-1 secondary payloads launched on SLS EM-1and deployed from the Multipurpose Crew Vehicle (MPCV) Stage Adapter (MSA). The safety process applies to individual payloads and hardware procured and delivered by the payload and dispenser developers. The term dispenser in this document is synonymous with the term deployer utilized in SPIE secondary payload documentation. The EM-1 PSRP process is to provide the SLS Program with an independent review and recommendation of the safety of the payload in regards to the SLS vehicle and possible effects to MPCV. The PSRP does not review the material in terms of individual payload successful operation or whether the payload will function to obtain the scientific data it was designed to collect. The intent of the PSRP is to ensure that the payload, in and of itself, does no harm to the SLS vehicle. The safety review processes associated with the SLS secondary payloads brackets, sequencer, battery, and cables are performed by the Spacecraft/Payload Integration and Evolution (SPIE) element in accordance with SLS Program SMA Requirements. Integrated safety review of SLS EM-1 secondary payloads, both at the SPIE integrated system level and SLS Vehicle system level, will be conducted by other SLS processes as defined in SLS Program SMA Requirements. SPIE will also perform integrated assessment of payload to payload hazards that could result in need

for additional information from the payload developer and will provide a recommendation to program on safety of payload to payload interactions.

The requirements (shall statements) within this document do not require a formal verification plan but are subject to documentation review/approval, audit, surveillance, and inspection activities.

1.3 Change Authority/Responsibility

The NASA Office of Primary Responsibility (OPR) for this document is SLS Program SMA.

Proposed changes to this document will be submitted by an SLS Program change request (CR) to the Program Control Board (PCB) for disposition. All such requests will adhere to the SLS-PLAN-008, SLS Program Configuration Management Plan.

2.0 DOCUMENTS

2.1 Applicable

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The documents listed in this paragraph are applicable to the extent specified herein.

ESD 10010 Rev A	Cross Program SMA Plan
SLS-PLAN-001A	SLS Program Plan
SLS-PLAN-004B	SLSP Data Management Plan
SLS-PLAN-008C	SLS Program Configuration Management Plan
SLS-PLAN-036A	SLSP Certificate of Flight Readiness Implementation Plan
SLS-RQMT-015B	SLS Program Hazard Analysis Requirements
SLS-PLAN-180A	SLSP Risk Management Plan
SLS-RQMT-216 Baseline	SLSP EM-1 Safety Requirements for Secondary Payload Hardware
SLS-SPIO-PLAN-029	SLSP SPIE Certification of Flight Readiness (CoFR) Implementation Plan
(TBD-001)	NASA KSC Payload Ground Safety Requirements

2.2 Reference Documents

The following documents contain supplemental information to guide the user in the application of this document.

ANSI Z136.1-2007	American National Standard for Safe Use of Lasers
IEC-60825-1 Ed. 3	Safety of Laser Products - Part 1: Equipment Classification and Requirements
JSC 20793	Crewed Space Vehicle Battery Safety Requirements
JWI 8705.3	Battery Processing

MIL-STD-1576	Electro-explosive Subsystem Safety Requirements and Test Methods for Space Systems
NASA-STD-5019	Fracture Control Requirements for Spaceflight Hardware
NSTS 22254	Methodology for Conduct of Space Shuttle Program Hazard Analysis
SLS-RQMT-014B	SLSP Safety and Mission Assurance (S&MA) Requirements
SSP 30309	Safety Analysis and Risk Assessment Requirements Document
SSP 51700	Payload Safety Policy and Requirements for the International Space Station
SSP 50021	Safety Requirements Document - International Space Station

3.0 ORGANIZATONAL ROLES AND RESPONSIBILITIES

3.1 Payload Developer

The payload developer is the party responsible for the design and manufacture of the secondary payload. It is the responsibility of each payload developer to assure the safety of its secondary payload and to implement the safety requirements of SLS-RQMT-216 and this document. Payload organization responsibilities include:

- Submitting the required aspects of the safety data package as outlined in this document in preparation for a phase safety review.
- Providing rationale for all waivers to safety requirements and processing waivers in accordance with this document.
- Participating in the phased safety reviews and providing any additionally requested support to the payload safety review panel.
- Providing necessary technical data to support the safety reviews and Certificate of Flight Readiness (CoFR) process.
- Performing an assessment of the integrated dispenser/payload hazards.

For the purposes of this plan, KSC Launch Services Program is considered a payload provider for the dispenser.

3.2 SLS EM-1 Payload Safety Review Panel (PSRP)

The SLS EM-1 PSRP has been assigned the responsibility for conducting safety reviews for SLS EM-1 secondary payloads. Membership of the PSRP will consist of the chairperson, and designated representatives from SLS Engineering, Flight Programs and Projects Directorate (FP), Spacecraft and Payload Integration and Exploration (SPIE), and SLS Safety and Mission Assurance (SMA). The PSRP chairperson is assigned by the SLS Program Manager. Other members are assigned by their respective organizations. Other ad hoc members include a designated representative from Ground Systems Development and Operations (GSDO), Multipurpose Crew Vehicle (MPCV), Flight Operations Directorate (FOD), and Exploration Systems Development (ESD) Integrated Hazard Analysis Working Group (IHAWG). The PSRP may require participation from additional members as needed to ensure technical expertise in review of the documentation. The SLS EM-1 PSRP will review payloads for safety for all phases of flight operations. The safety review panel responsibilities include the following:

- Evaluate the SDP submittals including Hazard Analysis, safety and/or technical analyses, safety reports etc. for safety compliance and provides a flight safety risk endorsement to SLS Program management after successful completion the safety review process.
- Conduct safety reviews during appropriate phases of payload development to assess the payload's compliance to the SLS Secondary Payload safety and process requirements.
- Assist the payload developer in the interpretation of safety requirements.

- Assign the flight safety risk classification for all submitted Hazard Analyses, including for each hazard cause, in accordance with ESD 10010, Cross Program SMA Plan, and SLS RQMT-015, SLS Program Hazard Analysis Requirements.
- Evaluate waivers against technical safety requirements and provide recommendation to SLS Program approval authority for disposition of waiver.
- Negotiate the resolution of safety issues involving design and operation to ensure compliance with all applicable safety requirements.
- Assess hardware design features that have been implemented for controlling identified hazards and the verification approach.
- Support SLS Program milestone reviews, as needed, with status of PSRP process and activities and readiness to support SLS and ESD program objectives and schedules.
- Submit required CoFR endorsements that provide the status and readiness of the SLS EM-1 PSRP process in accordance with SLS and ESD procedures.
- Approve and accepts the risk for low risk "green" hazards as identified in ESD 10010.
- Notify SLS program and ESD of any risks which require their acceptance per ESD 10010.

3.3 SLS Program

It is the responsibility of the SLS Program Manager to assign the chairperson for the EM-1 PSRP and to ensure the overall integrity of the safety and technical review of all submitted payload Safety Data Packages. The SLS Program will maintain the technical safety requirements and safety review process requirements for SLS EM-1 secondary payloads. SLS Program management will also make the determination whether or not to accept the risk documented in the appropriate hazard analysis as defined in ESD 10010, Cross Program Safety and Mission Assurance Plan, and make approval determinations for waivers to the SLS secondary payload safety requirements. The SLS program will maintain these approved hazard analysis and waivers according to SLS-PLAN-004, SLSP Data Management Plan.

3.4 SLS PSRP Chairperson

The chairperson shall conduct SLS EM-1 PSRP meetings and reviews in accordance with this document to ensure SLS EM-1 secondary payloads comply with defined safety requirements. The Chairperson has the discretion to determine which ad hoc members/organizations will be considered mandatory for any SLS EM-1 PSRP meeting or review.

3.5 SLS Engineering

The SLS Chief Engineer shall assign a member of the SLS Engineering team to act as a core member of the PSRP as defined in Section 3.2. SLS Engineering will provide additional support and expertise as needed to the SLS EM-1 PSRP as well as evaluation of payload safety waivers and identify potential impacts to the vehicle hardware.

3.6 SLS SMA

The SLS Chief Safety Officer will assign a member of the SLS SMA team to act as a core member of the SLS EM-1 PSRP as defined in Section 3.2 as well as provide additional support and expertise as needed to the SLS EM-1 PSRP. SLS SMA will also perform integrated hazard analysis of the integrated payloads at a SLS program integrated system level. SLS SMA will evaluate payload safety waivers and identify potential impacts to the vehicle hardware.

3.7 Spacecraft and Payload Integration/Evolution Office

SPIE will actively participate, as needed, in the payload safety review process and provide a point of contact to coordinate with the payload safety engineer (PSE). The SPIE organization will perform integrated hazard analysis of all interactions between the payload and SPIE element hardware, as well as interactions between two or more payloads, which will be documented in SPIE integrated hazards. Finally, endorsed hazards and waivers will be reviewed by the SPIE Engineering Change Board (ECB) for concurrence prior to submittal to the SLS Program Control Board (PCB).

3.8 Payload Safety Engineer (PSE)

A PSE will be assigned to each manifested SLS EM-1 secondary payload. The PSE, provided by MSFC SMA Science and Space Systems Assurance branch, acts as an intermediary between the payload developer and the PRSP. The PSE will act as an advisor on safety processes to the payload developer throughout all phases and will help to ensure all required safety data has been identified and is ready for review by the SLS EM-1 PSRP. The PSEs will be familiar enough with the safety aspects of each payload so that they may also advise the SLS EM-1 PSRP throughout the safety review process and will participate in all SLS EM-1 PSRP meetings for assigned payloads. As PSEs, they will facilitate the final hazard acceptance process for all payloads with the SLS Program and facilitate the approval of safety requirement waivers with the SLS Program. Additionally, they will serve as an interface between the SLS EM-1 PSRP and the SPIE organization and SLS program. The PSE will maintain the Safety Verification Tracking Log as defined in Section 4.3.5.1.1 to ensure all safety verifications are completed prior to flight. The PSE will also facilitate scheduling of informational briefings to the Program Control Board (PCB) after each phase review

3.9 PSRP Secretariat

The PSRP Secretariat will serve as the focal point for planning and organizing PSRP meetings and reviews. In addition the secretariat will maintain meeting minutes from each review and will be responsible to post all PSRP material to the PSRP website.

3.10 GSDO/GSRP

The KSC GSRP conducts ground safety reviews for SLS EM-1 secondary payloads. GSDO will review payloads for safety for pre-launch operations per KSC ground safety requirements

document **(TBD-001)** including any needed ground waivers, will provide approval for ground processing, and will retain records for ground processing.

3.11 Marshall Space Flight Center (MSFC) Flight Programs and Partnerships Office

Flight Programs and Partnerships Office interfaces with the SPIE Office on behalf of payload experiments approved for SLS flight. The FP organization will work with the SLS EM-1 PSRP and PSE to assure that the individual secondary payload elements are safe and meet the requirements of this document. FP will ensure that necessary technical and specialized expertise, including a payload integration manager, will be provided to the SLS EM-1 PSRP.

3.12 ESD SMA

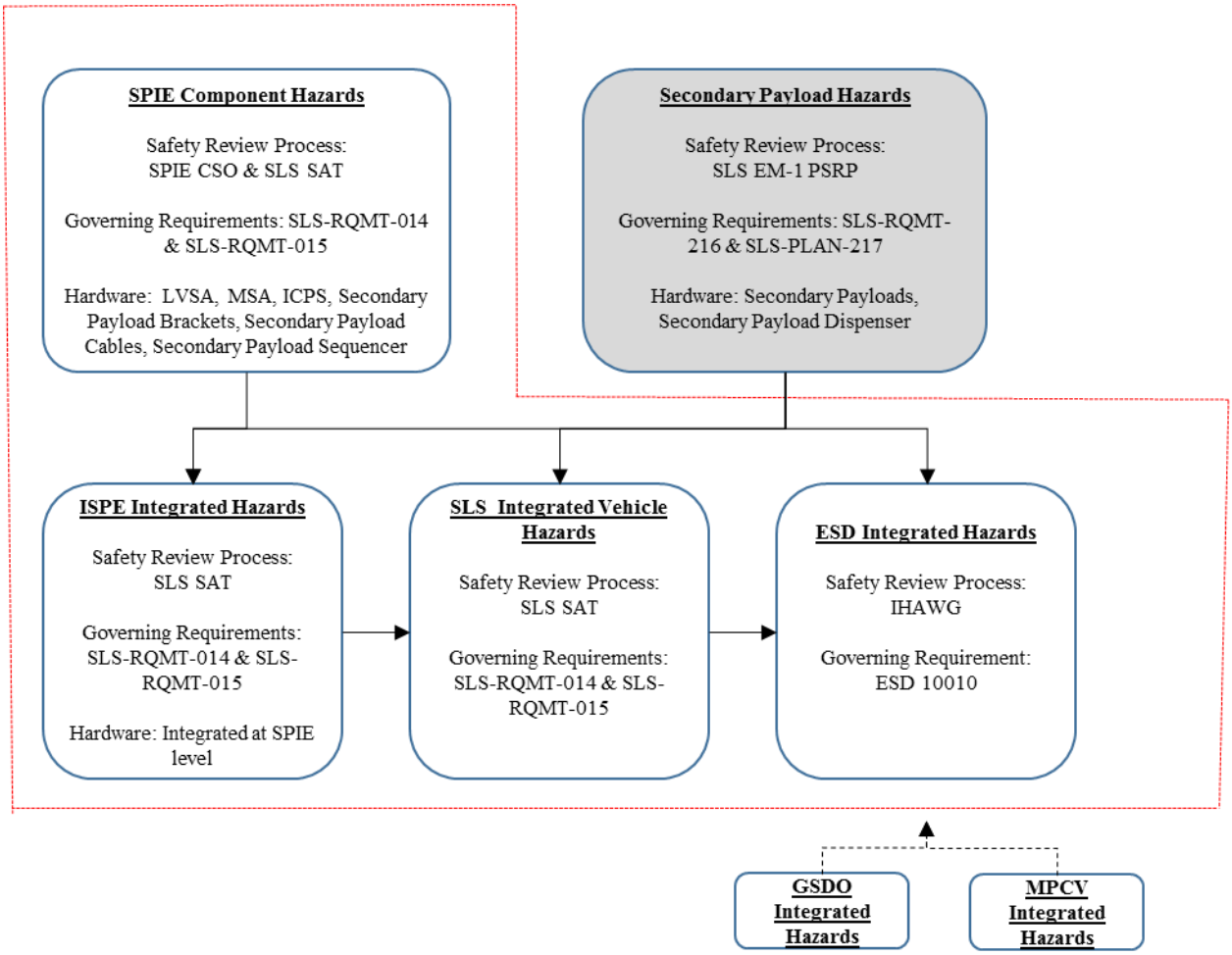
ESD SMA will be responsible for participating in SLS EM-1 PSRP meetings, as needed, and requesting payload information from the SLS EM-1 PSRP which is needed to perform the ESD cross program integrated hazard analysis. Hazards which are a result of a payload and which meet the definition of ESD integrated hazards will be addressed in ESD integrated hazard record. Detailed information on cross program integrated hazards may be found in ESD 10010.

3.13 PSRP Ad-Hoc Members

MPCV, FOD, GSDO, and ESD IHAWG will participate in the EM-1 SLS PSRP reviews as ad-hoc members. These members will participate to gain awareness and assess potential impacts of the EM-1 secondary payloads to their respective programs and areas of responsibility. They will also provide recommendations to the EM-1 SLS PSRP for needed controls against potential hazards that may be created by the EM-1 SLS secondary payloads.

4.0 SAFETY REVIEW PROCESS

The goal of the safety analysis is to identify hazards and to assure that proper hazard controls have been developed and implemented for all hazard causes which have not been eliminated. The safety review process (Figure 4-1) was developed to assess the results of these safety analyses conducted by developers of secondary payloads and to assure compliance of the payload to all safety requirements identified by the SLS Program for EM-1 secondary payloads. The safety compliance evaluation is accomplished using a phased safety review process (phases 0, I, II, III) that corresponds to the payload conceptual, preliminary, critical design, and final acceptance review phases. The safety review results are provided to the SLS Program after each safety review in support of SLS Element and Program activities.



- Hazard Analysis for each block can occur concurrently.
- This document only address safety activities / requirements within the gray box.

Figure 4-1. SLS Payload Safety Process

4.1 Safety Meeting Logistics

4.1.1 Meeting Types

4.1.1.1 In-Board Safety Review Meeting

These formal meetings are conducted to address the individual hazard analyses and waivers for a particular payload. Participants include: the safety review panel, representatives of the payload developer, and the appropriate supporting technical staff.

4.1.1.1.1 Phased Review Meeting

These formal in-board meetings are conducted to disposition hazard reports (HR), waivers, assigned actions and issues, and payload safety assessments. Delta phased reviews may be scheduled when the original phased reviews are not completed.

4.1.1.1.2 Special Topics Meeting

These formal in-board meetings are conducted to finalize dispositions on previously panel-reviewed HRs, assigned actions and issues, and payload safety assessments that require an additional formal safety review meeting. These meetings can be composed of multiple payload technical safety subjects in one meeting.

4.1.1.1.3 Safety Technical Interchange Meeting (TIM)

These formal in-board meetings assist in the interpretation of safety requirements, clarification of safety analyses/issues, or discussion of specific technical subjects as requested by the payload developer.

4.1.1.2 Outside-Of-Board (OSB) Safety Review Meeting

These informal meetings are conducted to finalize evaluations on previously panel-reviewed HRs, assigned actions and issues, and payload safety assessments that either do not require an additional formal safety review meeting or have been previously evaluated with minor changes. Participants include the safety review panel chairperson and applicable PSE. Representatives of the payload developer and the appropriate supporting technical staff may also be requested to participate.

4.1.1.3 Splinter/Working Group (WG) Meeting

These informal meetings may be held concurrently with or prior to a safety review to discuss detailed technical concerns and/or coordinate on resolution of issues in support of the safety review process. Participants include representatives of the payload developer and appropriate technical staff.

4.1.2 Phased Safety Review Meeting Agenda

Listed below are the general safety review meeting agenda items that ensure the associated meetings proceed smoothly and contain the necessary information to facilitate the review. The payload developer, in coordination with the PSE, will develop the detailed agenda for each meeting. The agenda submittal to the PSRP will be at least five days in advance of the phased SLS EM-1 PSRP meeting. Changes or additions to this agenda will be coordinated with the PSRP Secretariat prior to announcement of the review agenda.

1. Introduction of meeting and participants by the PSE
2. Opening remarks by the chairperson and payload developer
3. Status of pre-review activities, as applicable, by the PSE
4. SLS EM-1 secondary payload development milestone schedule including, but not limited to:
    a. Design stages and reviews and corresponding safety review panel dates
    b. Hardware/software build status
    c. Testing and verification activities
    d. Delivery, integration, and launch activities
5. A design overview/objective, including enough information to allow the panel to gain a general technical understanding of the systems and safety critical subsystems involved. Identify any design changes since previous safety reviews
6. An operations overview, including a description of planned operations and known contingencies. Highlight any operations that impact safety or are hazard controls
7. A summary of all non-conformances, anomalies, and significant technical issues. Provide additional information on those with safety impacts
8. Detailed presentation of HRs (and safety waivers if applicable) including phase-specific topics. Identify any updates since the previous submission of the HRs
9. Verification tracking log status (Phase III only)
10. Status of safety review meeting Action Item(s)
11. Concluding remarks.

Official minutes are prepared and made available to meeting attendees by the SLS EM-1 PSRP Secretariat. Minutes capture agreements, actions, and HR disposition/endorsement recommendations and are retained per Section 10.0.

4.1.3 Data Submittal

The required safety data package for the SLS EM-1 secondary payloads shall be submitted electronically no later than 14 calendar days prior to the scheduled meeting and/or requested review date otherwise the meeting must be rescheduled. The contents of these SDP are outlined for each phased review in Section 4.3. The applicable technical data in support of the HRs shall be submitted either attached to the HR or included in the SDP. This SDP shall be coordinated with the Secondary Payload Integration Manager (SPIM) and PSE prior to submittal to the SLS EM-1 PSRP. The submitted SDP shall include the payload manager's approval signature and the Phase III SDP shall include a signed certificate of payload safety compliance from the payload developer.

The submitted SDP will be made available to the PSRP members and other NASA/contractor (technical and administrative personnel) who support the safety review panel. NASA and any NASA contractors have obligations (e.g. Non-Disclosure Agreements) to honor the limited rights of any project information.

The payload developer is responsible for maintaining copies of all submitted data.

4.1.4 Meeting Scheduling

Payload developers shall schedule meetings based on the phased safety review process as defined in section 4.3. The payload developer shall coordinate with the PSE in order to set the review schedule to obtain maximum benefit to development based on the results of the safety reviews. Meetings will be scheduled upon receipt of an acceptable SDP.

The depth and number of the planned reviews are dependent on the complexity, technical maturity, and hazard potential of the payload as determined by the SLS EM-1 PSRP chairperson. Phased safety reviews may be combined as negotiated with the safety review panel chairperson and coordinated with the assigned payload safety engineer. If review phases are combined, the payload developer shall provide all the data requirements that apply to the appropriate phases.

4.2 Hazard Report Categories

Based on the phase I SDP, payloads hazards are categorized by the SLS EM-1 PSRP into one of two levels of complexity, basic or unique, as shown in Table 4-1, below. The review process is then tailored to this complexity of the payload design and adequacy of documentation. In addition, the hazard category dictates which formats may be used for the documentation of the hazard analyses.

Table 4-1 Hazard Report Categories

Hazard Category	
Basic	The payload has only standard hazards and appropriate standardized hazard controls which are part of a pre-identified list found on the Standardized Hazard Control Report (see Appendix F)
Unique	The payload has either: (a) standard hazards but unique controls and verification methods (other than those identified on the Standardized Hazard Control Report) or (b) Unique hazards which include, but are not limited to pyrotechnics, pressure systems, propulsion systems, and batteries.

If, after a hazard category has been assigned, the payload developer either identifies previously undefined hazards or implements design changes that may create new hazards, the payload developer must submit a revised SDP, which may result in a reclassification of the hazard category.

4.2.1 Hazard Report Format

Payloads have a very low level of complexity. The Payload Developers will submit a SDP using a Standardized Hazard Control Report, also known as a "Short Form" (Appendix F). Payload with unique hazards shall be addressed on a Unique Hazard Control Report, also known as a "long form" (Appendix G). The SLS EM-1 PSRP will determine the need for additional reviews at the completion of the first review. The SDP will document the applicable hazards, controls, and verifications. Details of the data package requirements for each phase are found in Section 4.3.2. Submittal will follow the standard procedure detailed in Section 4.1.3.

4.3 Phase Specific Information

Each payload will go through a phased safety review process. The sections below define the scheduling, objectives, safety data package requirements and results of each phase review. All ground hazards will be presented to GSDO for review and approval per the requirements of (**TBD-001).** The PSRP will assess ground operations and associated hazards in parallel with the GSDO review to determine whether ground processing activities could result in hazard that manifest themselves during SLS prelaunch or flight operations.

4.3.1 Phase 0 Technical Interchange Meeting (TIM)

4.3.1.1 Phase 0 Scheduling

The Phase 0 TIM is not a requirement but provides an opportunity for the payload developer to interact with the SLS EM-1 PSRP early within the design process and to receive initial feedback on safety hazards, preliminary controls, and verification approaches. As denoted in section 3.8, the payload provider will work with the PSE to schedule meetings with the SLS EM-1 PSRP.

Phase 0 is held during the concept phase or at the start of the payload design.

4.3.1.2 Phase 0 Objectives

1. Assist the payload developers in identifying hazards, hazard causes, and applicable safety requirements early in the development of the design.
2. Adequately describe the hazard likelihood.
3. Answer questions regarding the interpretation of the safety requirements or the implementation procedures of this document.
4. Provide guidance to the payload developers for preparing the safety data required for subsequent safety reviews.

4.3.1.3 Phase 0 TIM Data Requirements

If a Phase 0 TIM is planned, then the following are to be included by the payload developer as part of the Phase 0 TIM data and submitted as stated in paragraph 4.1.3:

1. Conceptual payload description (including subsystems) and mission scenario.
2. Description of safety-critical subsystems and their operations.
3. Preliminary identification of hazards.

The description of the payload and its operation must be of sufficient detail to permit identification of all subsystems that may create hazards. Emphasis should be given to those subsystems that store, transfer, or release energy. The descriptions of the safety-critical subsystems must be of sufficient detail to identify the hazards in terms consistent with the conceptual design.

4.3.2 Phase I PSRP Review

4.3.2.1 Phase I Scheduling

The Phase I review is associated with the payload's preliminary design phase and is scheduled per paragraph 4.1.4. As denoted in Section 3.8, at the request of the payload provider, the PSE shall schedule meetings with the PSRP.

4.3.2.2 Phase I Objectives

1. Ensure the adequacy of the initial/updated safety analysis (see Section 0), including all identified hazards and hazard causes that reflect the preliminary design and concept of operations of the payload and their interfaces.
2. Evaluate the means of eliminating, reducing, or controlling the risk.
3. Identify potential safety requirement waivers.
4. Identify approach for safety verification.

4.3.2.3 Phase I Safety Data Package Requirements

The following data is required to be included by the payload developer for the phase I safety reviews:

1. An overview description of the design and flight operations of the payload including:
    a. Flight and ground system interfaces
    b. Operational scenarios related to assembly, start-up sequences, and nominal operations to allow the SLS EM-1 PSRP to adequately address issues related to premature operations
    c. Payload part name(s) and number(s), if known
    d. Safety-critical subsystems
        i. Descriptions of safety-critical subsystems, their operations and interfaces, including schematics and block diagrams with safety features, inhibits, hazard controls, and monitoring provisions
        ii. Identification of any safety-critical subsystems that are computer controlled, and identification of the functional architecture associated with that computer control
        iii. A summary listing in the description section of dispenser features which lead to compliance with safety requirements
    e. Include figures or illustrations to show all major configurations and identify all hazardous systems and subsystems
    f. Provide a list of limited life items that could create a hazardous condition if they were to remain in service past their certification (design and/or operational) expiration date. Include a description of the failure mode and potential hazard created, and identify the safe operational life and safe design life for each item.
2. Flight HRs and appropriate support data (Appendix C) shall be submitted per paragraph 4.1.
3. List of hazard causes which have a green ranking per ESD 10010.

4.3.2.4 Phase I Outputs

After review of the submitted data, the SLS EM-1 PSRP will assign a hazard category per Section 4.2 and inform the payload developer of the need for any additional safety reviews based on the complexity of the payload. Successful completion of phase I review is accomplished by obtaining SLS EM-1 PSRP concurrence that the HRs are at the proper maturity level for Phase I. This concurrence to proceed to the next phase level will be noted in the minutes. The SLS EM-1 PSRP chairperson will also sign the hazard report with a statement that the hazard report has successfully completed the indicated SLS EM-1 PSRP phase review. The SLS EM-1 PSRP will provide an informational briefing on the Phase I results to the SLS PCB after the completion of the Phase I safety review.

4.3.3 Phase II PSRP Review

4.3.3.1 Phase II Scheduling

Phase II is associated with the payload's critical design phase and is scheduled per paragraph 4.1.4.

4.3.3.2 Phase II Objectives

1. Obtain panel approval of updated safety analyses that reflect the critical design and concept of operations of the payload and their interfaces
2. Assure that all appropriate hazard controls have been implemented
3. Assure that all verifications of the controls are documented
4. Identify potential safety waivers in detail
5. Document newly identified hazards in existing or additional HRs.

4.3.3.3 Phase II Safety Data Package Requirements

The following data is required to be included by the payload developer for the phase II safety review. Changes to technical support data since the Phase I SLS EM-1 PSRP presentation shall be annotated.

1. Updated overview descriptions of payload and flight operations:
    a. Flight and ground system interfaces
    b. Operational scenarios related to start-up sequences and nominal operations to allow the SLS EM-1 PSRP to adequately address issues related to premature operations
    c. Payload part name(s) and number(s)
    d. Updated descriptions of safety-critical subsystems, their operations and interfaces, including schematics and block diagrams with safety features, inhibits, hazard controls and monitoring provisions
    e. Identify any safety-critical subsystems that are computer controlled, and identify the functional architecture associated with that computer control

f. Include figures or illustrations to show all major configurations and identify all hazardous systems and subsystems

g. Provide an updated list of limited life items that could create a hazardous condition if they were to remain in service past their certification (design and/or operational) expiration date. Include a description of the failure mode and potential hazard created, and identify the safe operational life and safe design life for each item along with sufficient supporting verification data.

2. Updated flight HRs and appropriate support data (Appendix D) shall be submitted per Paragraph 4.1.
3. List of hazard causes which have a green ranking per ESD 10010.
4. Identification of flight safety waivers.
5. A summary listing of safety-critical services provided by other elements.
6. A record of test failures, anomalies, and accidents involving qualification or potential flight payload. Include a safety assessment for items which may affect safety.
7. Status of action items assigned during previous safety reviews.

4.3.3.4 Phase II Outputs

Successful completion of phase II review is accomplished by obtaining SLS EM-1 PSRP concurrence that the HRs are at the proper maturity level for Phase II. This concurrence to proceed to the next phase level will be noted in the minutes. The SLS EM-1 PSRP chairperson will also sign the hazard report with a statement that the hazard report has successfully completed the indicated SLS EM-1 PSRP phase review. The SLS EM-1 PSRP will provide an informational briefing on the Phase II results to the SLS PCB after the completion of the Phase II safety review.

4.3.4 Phase III PSRP Review

4.3.4.1 Phase III Scheduling

Phase III is associated with completion of hardware manufacturing and test prior to the payload delivery for ground processing and the review is scheduled per Paragraph 4.1.4. The SLS EM-1 PSRP reviews shall be completed no later than 30 calendar days prior to delivery of the payload to the next level integrator (e.g. packing or launch site facility). When establishing a timeline for Phase III, the payload developer should allow enough time to close potential issues that may result from a Phase III review.

4.3.4.2 Phase III Objectives

1. Present the final safety analysis that identifies all hazards and hazard causes, resolves any safety waivers, and identifies all safety verification methods and status.
2. Obtain panel final endorsement of the safety analysis that reflects the design and concept of operations of the payload and its interfaces.

4.3.4.3 Phase III Safety Data Package Requirements

The following data is required to be included by the payload developer for the Phase III safety review. Changes to technical support data since the previous SLS EM-1 PSRP presentation shall be annotated.

1. Updated overview descriptions of the as-built hardware and flight operations:
    a. Flight and ground system interfaces,
    b. Operational scenarios related to start-up sequences and nominal operations to allow the SLS EM-1 PSRP to adequately address issues related to premature operations
    c. Payload part name(s) and number(s)
    d. Updated descriptions of safety-critical subsystems, operations and interfaces, including schematics and block diagrams with safety features, inhibits, hazard controls and monitoring provisions
    e. Identify any safety-critical subsystems that are computer controlled, and identify the computer-based control system (CBCS) architecture, software description, and final CBCS system design associated with that computer control
    f. Include figures or illustrations to show all major configurations and identify all hazardous systems and subsystems
    g. Provide a list of limited life items that could create a hazardous condition if they were to remain in service past their certification (design and/or operational) expiration date. Include a description of the failure mode and potential hazard created, and identify the safe operational life and safe design life for each item along with sufficient supporting verification data
2. Completed flight HRs and appropriate support data (Appendix E)
3. List of hazard causes which have a green ranking per ESD 10010
4. Listing of waivers to safety requirements. A signed copy of each approved waiver shall be included
5. A summary listing in the description section, of safety-critical services provided by other elements
6. Safety Verification Tracking Log (Section 4.3.5.1.1) that identifies open safety verification methods and detail as to status including the timeframe for closure of the verification
7. An updated record of test failures, anomalies, and accidents involving qualification or potential flight payload or baselined flight software if the software is used for hazard control. Include a safety assessment for items which may affect safety
8. Closure of action items assigned during previous safety reviews

9. Certificate of Compliance from payload developer that all hardware has been built to safety requirements, waivers processed and approved as required, and hazards assessed and documented per this document and payload is safe to fly. (see Appendix J).

4.3.4.4 Phase III Outputs

The SLS EM-1 PSRP provides a recommendation to the payload developer at the completion of the Phase III review. The recommendation takes one of the following forms:

Table 4-2. Phase III Recommendations

Phase III Recommendation	
Endorsed As Is	• Technically concurred with presented HR(and/or HR cause) • Recommend approving authority approve as is.
Endorsed With Modifications	• Technical discussion completed and modifications agreed to between panel and payload developer.
Deferred	• Panel did not reach a consensus for HR (and/or HR cause) approval. • Further technical discussion with payload developer still required. Chairperson provides direction on forward plan to resolve HR (and/or HR cause) approval.
Rejected	• Panel does not concur with the final hazard report / cause presented and there are no forward plans to resolve the issue. • Recommend approving authority not approve hazard report

Successful completion of phase III review occurs when:

1. All safety analysis efforts are complete and the HRs are at the proper maturity level for Phase III
2. All potential risks to the flight from the payload, including the dispenser, have been sufficiently controlled
3. The final risk classifications for the hazard reports are accurate
4. Safety review action items and comments associated with HRs are formally closed.
5. All waivers are signed, if applicable

The SLS EM-1 PSRP Phase III recommendation to the payload developer will be documented by notation in the SLS EM-1 PSRP minutes

The SLS EM-1 PSRP also provides a recommendation to the hazard approving board and SPIE in support of the CoFR process at the completion of the Phase III safety review. The recommendation takes one of the following forms:

Table 4-3. Safety Review Recommendations

Phase III Recommendation to Approving Authority	
Endorsed As Is	• Technically concurred with presented HR(and/or HR cause) • Recommend approving authority approve as is.
Rejected	• Panel does not concur with the final hazard report / cause presented and there are no forward plans to resolve the issue. • Recommend approving authority not approve hazard report

The SLS EM-1 PSRP Phase III recommendation (Section 8.0) will be documented by:

1. Notation in the SLS EM-1 PSRP minutes as part of the records retention (see Section 10.0)
2. Completion of Certificate of Endorsement (See Appendix H) for HR(s) being recommended for approval
3. The SLS EM-1 PSRP chairperson signature on the hazard report with a statement that the hazard report has successfully completed the SLS EM-1 PSRP phase III review.

If a hazard report recommendation is “Rejected”, the PSRP Chairman will bring these results to the SLS PCB.

Once the SLS EM-1 PSRP has determined a recommendation, the safety data shall be posted to the safety panel website to support CoFR milestone activities.

4.3.5 Post Phase III Activities

4.3.5.1 Changes / Anomalies

If there are changes/anomalies post-Phase III to the payload, the payload developer shall assess those changes/anomalies for safety impacts and forward the assessment for safety review panel disposition. This submittal should be coordinated with the assigned PSE per Section 4.1.4. New or revised HRs and support data shall be prepared and submitted where applicable. Significant changes, as determined by the SLS EM-1 PSRP chairperson, may require a delta phase safety review. If the change has ground safety implications, it will be reviewed and approved by the GSDO prior to proceeding/continuing with KSC ground processing.

4.3.5.1.1 Safety Verification Tracking Log (SVTL)

All completed verification work shall be documented on the appropriate HR(s). The SVTL is used to formally document and status safety verification work that is not completed at the time the Phase III HR(s) is (are) prepared.

The SVTL (see Appendix I), which can be used for both flight and ground, shall include:

1. HR number/title
2. Hazard cause/control/verification number
3. Verification method with status
4. Any operational constraints
5. Indication as to whether independent verification is required
6. Scheduled and actual verification completion dates
7. Indication as to whether the verification is used for ground or flight hazards.

Following the endorsement of the phase III HR(s), the SVTL will be provided to SPIE for incorporation into their CoFR process. Verifications which are "closed to SVTL" that are not part of normal operations will be tracked as CoFR exceptions per SLS-PLAN-036, SLSP Certification of Flight Readiness Implementation Plan. The PSE will serve as the interface between SPIE and the SLS EM-1 PSRP to ensure the closure review of verifications with CoFR exceptions are routed through the SLS EM-1 PSRP in support of their CoFR role.

Any verification items remaining open on the flight HRs after completion of Phase III that are determined to be a constraint to KSC ground operation shall be identified as such on the SVTL and the payload provider shall provide rationale to support the safety of starting KSC ground processing. The payload provider should reference **(TBD-001)** for all safety requirements and documentation required by GSDO.

5.0 PSRP SAFETY ENDORSEMENT

At the successful completion of Phase III, the PSRP will provide an endorsement that all submitted safety data and hazard analyses show compliance with all safety requirements of this document and SLS-RQMT-216 and that per the PSRP review, the payload shows an acceptable level of risk to SLS flight safety. This endorsement will be submitted to the SPIE element office and to the payload provider organization to support the element CoFR process and integrated hazard analysis as necessary. This endorsement will also be submitted to the appropriate approving authority of the hazard analysis per ESD10010.

It is the responsibility of the chairperson of the SLS EM-1 PSRP to assure that all safety discussions and decisions are adequately vetted thru the SLS EM-1 PSRP. Consensus of all PSRP members (core and ad hoc) is desired but not required. The PSRP chairperson will determine the final endorsement of the panel in the event of a disagreement. In the event of a significant disagreement, any member of the PSRP may use the Dissenting Opinion process as provided in SLS-PLAN-001, SLS Program Plan.

6.0 HAZARD ANALYSIS

Performance of hazard analyses provides a means to systematically identify hazards, their causes and controls if the hazard cannot be eliminated from the design. Documents such as SSP 30309, Safety Analysis and Risk Assessment Requirements Document, and NSTS 22254, Methodology for Conduct of Space Shuttle Program Hazard Analysis, provide guidance for methodologies and examples to document traditional safety analysis techniques. The HR summarizes how the payload design and operations demonstrate compliance with the safety requirements.

The payload provider shall provide a list of hazard causes which the provider has ranked as "green" risks per ESD 10010. If the SLS PSRP concurs with the green ranking, these hazard causes do not require further development; the listing shall be included as part of the flight SDP. The flight SDP submittal must contain all flight HRs; the ground SDP submittal must contain all ground HRs.

6.1 Phased Hazard Report Development

A Phase I HR shall be prepared for each hazard identified as a result of the safety analysis on the preliminary design and operations (Preliminary Design Review (PDR) level of detail). The focus shall be on hazard cause descriptions and controls. Phase I hazard analysis should have all potential hazard causes identified and a control strategy for the causes identified

The Phase II HRs shall be prepared by updating the safety hazards analysis to reflect the hardware design maturity at CDR. These new and/or updated HRs reflect the completed payload design and flight/ground operating procedures. Phase II HRs shall document the payload design and operations, updated causes and controls, final verification approaches. If the payload design is changed from Phase I to Phase II such that a Phase I HR can be deleted, a brief statement of rationale for deleting the report shall be presented in the Phase II assessment report.

The Phase III HRs shall document the final payload design and operations, causes and controls, verification methods and closure status of verifications

All changes to the HRs shall be tracked to understand the nature of the change

The hazard assessment shall be documented on the appropriate hazard report format based on the payload complexity determined per Section 4.2.

6.2 Hazard Ranking

All hazard causes will be given a risk classification in accordance with requirements of ESD 10010; this risk classification will be documented in the hazard report. The payload may propose the ranking based on the severity and likelihood definitions in ESD 10010. The EM-1 PSRP is responsible to make the final determination of hazard cause ranking in line with the requirements of ESD 10010.

7.0 HAZARD APPROVAL PROCESS

Approving authority of the hazard analysis is based on the requirements outlined in ESD 10010 and SLS-RQMT-015. Figure 7-1**Error! Reference source not found.** illustrates in summary form the process for approval of payload hazard analysis/reports.

The SLS EM-1 PSRP will approve hazard analyses which are low risk-"green" upon successful completion of the Phase III review.

For medium and high risk hazards, once the PSRP Phase III review is complete, the PSRP provides an endorsement as detailed in Section 5.0 that the hazard analysis is compete and all identified hazards have been controlled/mitigated to an appropriate level for flight vehicle safety. This endorsement along with the hazard analysis is first submitted to the SPIE Element control boards for review and concurrence. Once this review is complete, the hazard analysis is submitted to the SLS Program CECB/PCB for review through the SLSP CR process as detailed in SLS-PLAN-008. If ESD 10010 requires a higher level approval authority other than the SLS PCB, the CR will be submitted with the hazard analysis per the approving boards required processes. The PSE will facilitate the review and approval process through all appropriate boards.

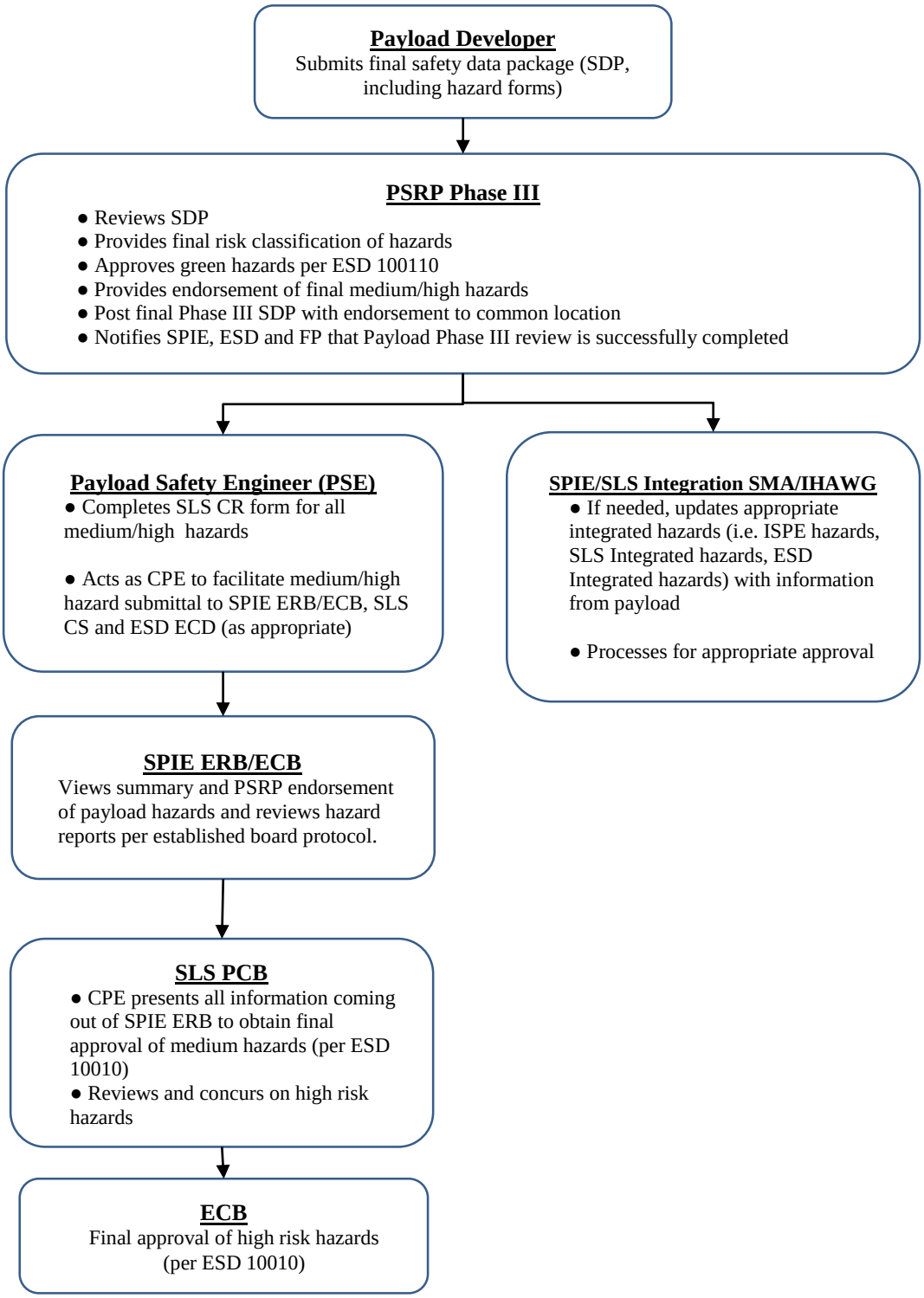


Figure 7-1. Hazard Report Approval Flow

8.0 WAIVERS

Any payload safety requirement of this document or SLS-RQMT-216 that the payload developer cannot comply with will require a waiver to be processed and approved. Identification and approval of all waivers early in the design cycle is highly encouraged.

Waivers to safety requirements shall be submitted on MSFC Form 847 per SLS-PLAN-008, SLSP Configuration Management Plan, to the SLS PCB for approval. In addition to the waiver form, the payload developer will provide a risk assessment which includes

- Technical rationale for acceptance and flight safety
- Mitigation/controls of any hazard due to noncompliance
- A 5×5 risk matrix in accordance with SLS-PLAN-180, SLSP Risk Management Plan.

Prior to presentation for approval at the SLS PCB, the waiver will be reviewed and concurred upon by the SLS EM-1 PSRP. Subsequently the waiver will be reviewed and should be concurred upon by the SPIE engineering and project control boards prior to SLS PCB review. The PSE will facilitate the review and approval of the waivers. All waivers should also be communicated with integrated hazard developers for impact assessment to the integrated hazard analysis. Figure 8-1 outlines this process.

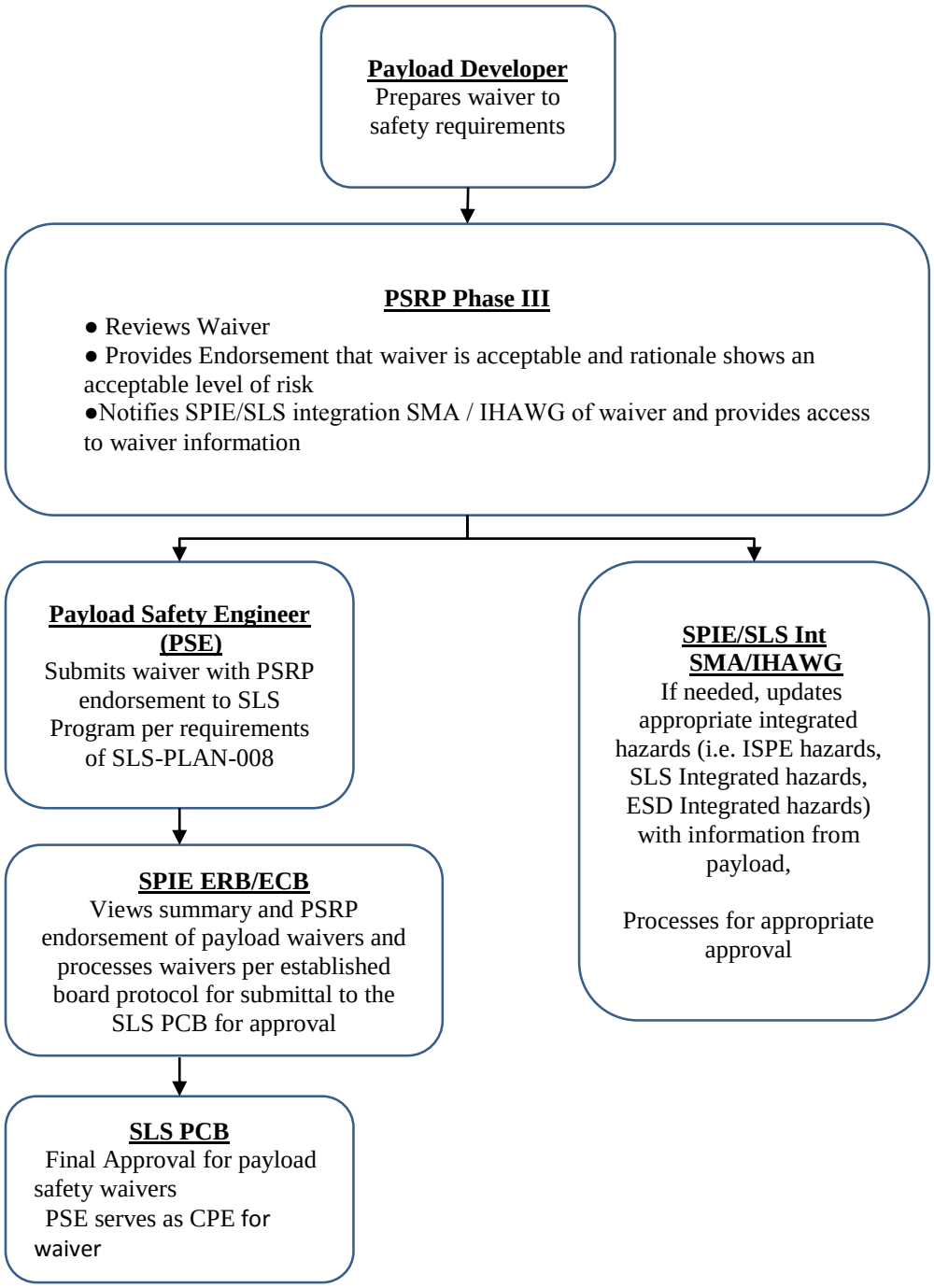


Figure 8-1. Waiver Process

9.0 CERTIFICATE OF FLIGHT READINESS (COFR)

Upon completion of Phase III and final approval of all hazard analysis and waivers, the SLS EM-1 PSRP chairman will provide an endorsement stating the PSRP has reviewed all required safety data and that the associated hazard analysis, waivers, and safety data indicate an acceptable level of risk to the flight vehicle (see Section 5.0). This endorsement is provided to the SPIE CoFR process (Figure 9-1**Error! Reference source not found.**) per SLS-SPIO-PLAN-029, SLSP SPIE ertification of Flight Readiness (CoFR) Implementation Plan.

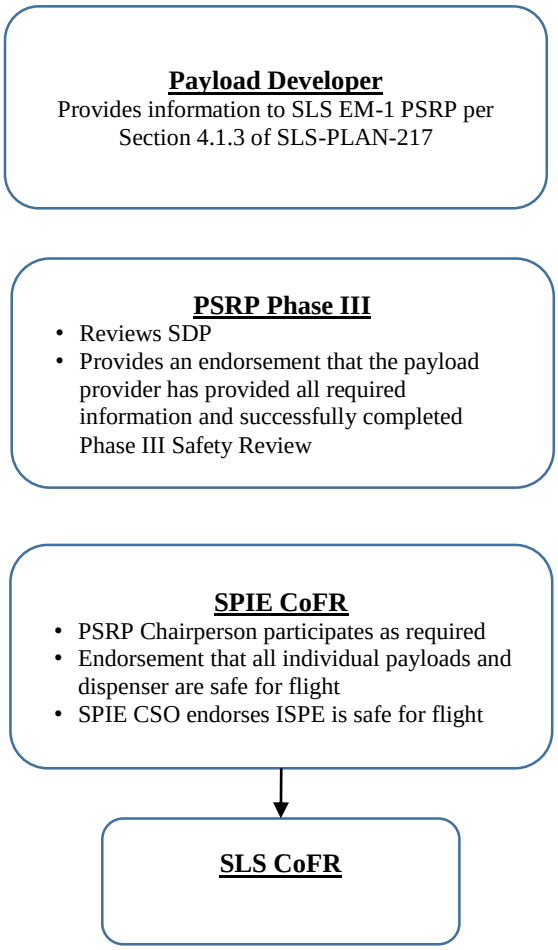


Figure 9-1. CoFR Process

10.0 RECORDS RETENTION

Records generated and forms used by the SLS EM-1 PSRP are retained and maintained by the MSFC SMA on behalf of the SLS Program.

APPENDIX A
ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS

A1.0 ACRONYMS AND ABBREVIATIONS

CBCS	Computer-based Control System
CDR	Critical Design Review
CE	Conducted Emissions
CoFR	Certificate of Flight Readiness
COPV	Composite Overwrap Pressure Vessel
CR	Change Request
CS	Conducted Susceptibility
CW	Continuous Wave
DCP	Damage Control Plan
DFMR	Design For Minimum Risk
EM-1	Exploration Mission-1
EMC	Electromagnetic Compatibility
EMEP	Electromagnetic Effects Panel
EMI	Electromagnetic Interference
ESD	Exploration Systems Development
FCP	Fracture Control Plan
FCSR	Fracture Control Summary Report
FP	Flight Programs and Projects Directorate
GSDO	Ground Systems Development and Operations
GSE	Ground Support Equipment
GSRP	Ground Safety Review Panel
HR	Hazard Report
IHAWG	Integrated Hazard Assessment Working Group
KSC	Kennedy Space Center
MDP	Maximum Design Pressure
MIP	Mandatory Inspection Point
MPCV	Multi-Purpose Crew Vehicle
MSA	MPCV Stage Adapter

MSDS	Material Safety Data Sheet
NDE	Nondestructive Evaluation
NHZ	Nominal Hazard Zone
NOHD	Nominal Ocular Hazard Distance
PDR	Preliminary Design Review
PSE	Payload Safety Engineer
PSRP	Payload Safety Review Panel
RE	Radiated Emissions
RF	Radio Frequency
RS	Radiated susceptibility
SDP	Safety Data Package
SEMP	Systems Engineering Management Plan
SLS	Space Launch Systems
SMA	Safety and Mission Assurance
SPIE	Spacecraft/Payload Integration and Evolution
SPIM	Secondary Payload Integration Manager
SVTL	Safety Verification Tracking Log
TIA	Tailoring Agreements

A2.0 GLOSSARY OF TERMS

Term	Description
Concurrence	A documented agreement by a management official that a proposed course of action is acceptable
Safety Critical	1) An operation, process, system, or component that controls or monitors equipment, operations, systems, or components to ensure personnel, launch area, and public safety; may be hazardous or non-hazardous. 2) A condition, event, operation, process, function, equipment, or system (including software and firmware) with potential for personnel injury or loss, or with potential for loss or damage to vehicles, equipment or facilities, loss or excessive degradation of the function of critical equipment, or which is necessary to control a hazard.
Secondary Payload	Hardware or systems manifested on the flight for science, technology, or medical investigations in destination orbits and environments not readily achievable by other means, and are not part of the primary mission.
Secondary Payload Deployment System	The SLS SPIE Secondary Payloads Deployment System consists of the dispenser, sequencer, battery, and cables for the EM-1 mission.

Term	Description
Standard Hazard	Pre-identified hazards listed on the Standardized Hazard Control Report found in Appendix F.
Unique Hazard	Hazards not listed on the Standardized Hazard Control Report found in Appendix F. These hazards usually require fault tolerance to be incorporated into the payload design.

APPENDIX B
OPEN WORK

All resolved TBDs, TBRs, and forward work items should be listed on the Change Request (CR) the next time the document is updated and submitted for formal review, and that will serve as the formal change record through the configuration management system.

B1.0 TO BE DETERMINED

Table B1-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within carets. The TBD item is sequentially numbered as applicable (i.e., **<TBD-001>** is the first undetermined item assigned in the document). As each TBD is resolved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

Table B1-1. To Be Determined Items

TBD	Section	Description
TBD-001	2.1	Need reference for KSC Ground Safety Document which is currently in development

APPENDIX C
PHASE I TECHNICAL DATA SUBMITTAL

HAZARD REPORT SUPPORT DATA

1) Structures (Check List)

- ☐ a) Proposed Structural Verification Plan in accordance with structural safety requirements.
- ☐ b) Fracture Control Plan (FCP) in accordance with applicable fracture control requirements.
- ☐ c) Damage Control Plan (DCP) for structural composite/bonded structures and/or Composite Overwrapped Pressure Vessel (COPV), as applicable.
- ☐ d) Methodology for assurance of fastener integrity.
- ☐ e) Preliminary identification of all materials, their intended use, configuration, and verification approach to assure that the material failure will not result in a hazardous condition.

2) Pressure Systems (Check List)

- ☐ a) Preliminary pressurized system schematic, operating parameters (e.g., temperature, pressure and other environmental conditions) and certification approach.
- ☐ b) Preliminary summary of the derivation of system Maximum Design Pressures (MDPs).
- ☐ c) Preliminary list of all system working fluids, their complete chemical composition, amounts, potential hazards (e.g., flammability, explosion, corrosion, toxicity) and hazard category (e.g., catastrophic, critical, non-hazard).
- ☐ d) FCP in accordance with applicable fracture control requirements.
- ☐ e) DCP for structural composite/bonded structures and/or COPV, as applicable.
- ☐ f) Preliminary table to show compliance with pressure systems safety requirements with columns for: 1) Item - (lines and fittings, components, or pressure vessel), 2) Ultimate strength (design burst pressure), 3) system MDPs, 4) Factor of Safety (actual) as compared to Factor of Safety (required), 5) Proof Test Factor (Maximum Proof Test Pressure divided by MDP), 6) Leak rate method used for hazardous materials and 7) Containment integrity required (maximum allowed leak rate). If the Proof Test Factor will be less that 1.5 X MDP provide an explanation.
- ☐ g) Proposed pressurized system(s) verification approach for controls to ensure pressure integrity.
- ☐ h) For fluids whose leakage is hazardous also include: Proposed pressurized system(s) verification approach including controls to prevent leakage.

i) For the DFMR approach to protect against leakage that may cause a catastrophic hazard include, but not limited to: 1) identification of mechanical fitting and leakage certification approach for wetted areas. Consider all environments where leakage is hazardous and 2) preliminary identification of fusion and bi-metallic joints within the system.

3) Pyrotechnic Devices (Check List)

a) List of pyrotechnic devices and the functions performed.

b) Controls in accordance with MIL-STD-1576, Electro-explosive Subsystem Safety Requirements and Test Methods for Space Systems.

4) Material Compatibility, Toxicity, Flammability, and Toxic Offgassing (Check List)

a) Approach used to assure materials compatibility.

b) A tabulated list of tentative toxic materials and support data.

c) Preliminary materials assessment.

5) Ionizing Radiation (Check List)

a) Provide a list of all Ionizing Radiation Sources and include the following data for each source: 1) Type of material, 2) Amount of material, 3) Type and worst case intensity of the radiation given off of that source (α, β, γ), 4) Proposed use of that source, 5) Plan for providing shielding (if necessary), and 6) Identify whether or not a keep out zone is needed for that source.

b) KSC Forms per KNPR 1860.1

6) Non-Ionizing Radiation (Check List)

a) List of equipment that generates non-ionizing radiation (RF transmitters, light sources, etc.).

b) Proposed Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) Test Plan, for Conducted Emissions (CE), Radiated Emissions (RE), Conducted Susceptibility (CS), and Radiated Susceptibility (RS); applicable tests as determined by the hardware intended application and criticality.

7) Permanent Magnets (Check List)

a) Identify all permanent magnets, quantity, and magnetic field intensity/values.

8) Non-Ionizing Radiation - Lasers (Check List)

- ☐ a) Identify each laser, its operating location, and its complete beam path.
- ☐ b) Identify the laser hazard classification per ANSI Z136.1-2007 or IEC-60825-1 Ed. 3.
- ☐ c) Identify each laser's operating characteristics (wavelength(s), Continuous Wave (CW)/pulsed).
- ☐ d) For CW lasers, provide average and peak powers.
- ☐ e) For pulsed lasers, provide pulse shape and energy characteristics and repetition frequency.
- ☐ f) Provide the laser manufacturer's specification sheet, if available.
- ☐ g) Identify each laser's transmission characteristics (beam diameter and beam divergence at accessible apertures, intensity profile) (class 1M, 2M, 3R, 3B and 4 only). Preliminary Nominal Ocular Hazard Distance (NOHD) and/or Nominal Hazard Zone (NHZ) analysis including a list of assumptions used in the analysis (window transmission factors, maximum exposure durations, atmospheric attenuation, reflections, etc.) (class 1M, 2M, 3R, 3B and 4 only) as defined by the ANSI Z136.1-2007.
- ☐ h) Preliminary description of controls and inhibits to contain laser beam or prevent inadvertent laser operation and/or crew exposure (interlocks, barriers, beam stops, etc.)
- ☐ i) KSC Forms per KNPR 1860.2

9) Electrical Systems (Check List)

- ☐ a) Power distribution schematic(s) showing wire sizing and circuit protection.
- ☐ b) Bonding and grounding diagram.
- ☐ c) Diagrams for power distribution inhibits/controls for hazardous functions or controls.

10) Avionics Control (Check List)

- ☐ a) Preliminary diagram of safety-critical subsystems, that indicate inhibits, controls, and monitors.
- ☐ b) Preliminary verification approach for electrical safety-critical subsystems.

11) Computer Systems (Check List)

Note
This section applies only to computer systems used to control hazardous functions.

- ☐ a) Identify the specific features of the computer system used to control the hazard on the hazard report.

- ☐ b) Describe the function(s) controlled by computer system that prevent a hazard from occurring or control a hazardous function.
- ☐ c) Provide a block diagram of the Computer-Based System with all inhibits to a hazard identified and describe how the inhibits independently control the hazard, including clear identification of control paths or other independent inhibit control methods.
- ☐ d) Provide design features for Computer Based Systems planned to control multiple inhibits to a hazard (i.e. designed to be greater than zero-fault tolerant).
- ☐ e) Describe the development process (including verification) of software/hardware and computer based control.

12) Mechanisms in Critical Applications (Check List)

- ☐ a) Identification of areas of applicability of holding or operating force or torque margin requirements
- ☐ b) Planned verification approach (test or analysis)
- ☐ c) Provide a summary of critical procedures and processes to meet safety requirements using either a) failure tolerant approach or b) DFMR approach. A fault tolerant approach that combines a) and b) above will be accepted.
- ☐ d) Preliminary functional verification matrix

13) Batteries (Check List)

- ☐ a) Preliminary list of type and number of cells and batteries, details of application and usage loads and environments, cell size (capacity), battery configuration (series/parallel), cell/battery chemistry, cell/battery manufacturer, model number(s), voltage, capacity, details of pre-flight test plan and on-orbit operations.
- ☐ b) Preliminary design approach to fault tolerance or design for minimum risk strategy to meet battery safety requirements of JSC 20793, "Crewed Space Vehicle Battery Safety Requirements."

14) Sealed Containers (Check List)

- ☐ a) List the name of each sealed container.
- ☐ b) Provide preliminary identification of MDP, fluid(s), materials of construction for container enclosure, stored energy due to pressure, and environmental conditions.
- ☐ c) Confirm/show sealed container meets design requirements per NASA-STD-5019 for sealed containers.

15) Biological Materials (Check List)

- ☐ a) List of biological materials.

APPENDIX D
PHASE II TECHNICAL DATA SUBMITTAL

Hazard Report Support Data

1) Structures (Check List)

- ☐ a) Final structural verification plan, including: 1) summary of design loads derivation leading to critical load cases, and 2) math model verification plan.
- ☐ b) Fracture Control status and parts categorization, which shall include but not limited to the list of fracture critical and low-risk fracture parts.
- ☐ c) Any unique or alternate approaches used in Fracture Control that require the approval of the Fracture Control authority.
- ☐ d) Updated identification of all materials, their intended use, configuration, and verification approach to assure that the material failure will not result in a hazardous condition.

2) Pressure Systems (Check List)

- ☐ a) Complete and updated pressurized system schematic(s) and operating parameters, addressing all pressurized hardware.
- ☐ b) Complete summary of the derivation of system MDP(s) per applicable technical safety requirements.
- ☐ c) Complete table of pressurized system hardware, MDP(s), proof pressure, ultimate pressure, resulting proof and ultimate safety factors and method of determining the safety factors (e.g., test, analysis, vendor data) should be fully disclosed except for information not yet available with respect to "Proof Factor (Maximum Test Pressure)" and "Leak rate method used for hazardous materials".
- ☐ d) Updated list of all system working fluids, their complete chemical composition, amounts, identified hazards and hazard category. Status on pressure vessel(s) design and qualification.
- ☐ e) Fracture Control status and parts categorization, which shall include but not limited to the list of fracture critical and low-risk fracture parts.
- ☐ f) Any unique or alternate approaches used in Fracture Control that require the approval of the Fracture Control authority.
- ☐ g) Updated identification of all materials, their intended use, configuration, and verification approach to assure that the material failure will not result in a hazardous condition.
- ☐ h) Final pressurized system(s) verification approach for controls to ensure pressure integrity including a summary of qualification and acceptance test plans and analyses.

- ☐ i) For fluids whose leakage is hazardous include: Final pressurized system(s) verification approach including controls to prevent leakage (e.g., levels of containment, DFMR). Include a summary of qualification and acceptance test plans and analyses.
- ☐ j) For the DFMR approach to protect against leakage that may cause a catastrophic hazard include: 1) summary of certification test plans and analyses to prevent leakage of wetted mechanical fittings, 2) identification of system fusion joints and their method of Nondestructive Evaluation (NDE). Identification of system bi-metallic joint(s), manufacturer and certification data, and 3) complete list of wetted materials and their compatibility rating with system and cleaning fluids. Define credible single barrier failures which may release fluid into a volume that is not normally wetted and provide a summary of maximum worst case temperatures which were considered.
- ☐ k) Qualification and acceptance test plan

3) Pyrotechnic Devices (Check List)

- ☐ a) Detailed drawings of devices.
- ☐ b) Chemical composition of any booster charge(s).
- ☐ c) Inspection plan(s) for critical components.
- ☐ d) Plan for evaluation of aging degradation.
- ☐ e) Verification plan summary, including acceptance and qualification approach(s) (including margin demonstration), in accordance with MIL-STD-1576 Electro-explosive Subsystem Safety Requirements and Test Methods for Space Systems.
- ☐ f) For pyrotechnic devices which must operate reliably in order to meet safety requirements, an acceptance and qualification plan shall be cleared and accepted by the MSFC Engineering and SMA Pyrotechnic Team

4) Material Compatibility, Toxicity, Flammability, and Toxic Offgassing (Check List)

- ☐ a) List of toxic materials and their Material Safety Data Sheets (MSDSs).
- ☐ b) Updated materials assessment
- ☐ c) Status on evaluation of materials compatibility with fluids

5) Ionizing Radiation (Check List)

- ☐ a) Updated list of all Ionizing Radiation Sources and include the following data for each source: 1) Type of material, 2) Amount of material, 3) Type and worst case intensity of the radiation given off of that source (α, β, γ), 4) Proposed use of that source, 5) Plan for providing shielding (if necessary), and 6) Identify whether or not a keep out zone is needed for that source.
- ☐ b) KSC Forms per KNPR 1860.1

6) Non-Ionizing Radiation (Check List)

- ☐ a) Updated list of equipment that generates non-ionizing radiation, including expected nominal operational characteristics of all non-ionizing radiation sources.
- ☐ b) Final EMI/EMC Test Plan, for CE, RE, CS, and RS: applicable tests as determined by the hardware's intended application and criticality.
- ☐ c) KSC Forms per KNPR 1860.2

7) Permanent Magnets (Check List)

- ☐ a) Updated listing of all permanent magnets, quantity, and magnetic field intensity/values.

8) Non-Ionizing Radiation - Lasers (Check List)

- ☐ a) Final NOHD/NHZ analysis (class 1M, 2M, 3R, 3B and 4 only) as defined by the ANSI Z136.1-2007.
- ☐ b) Final description of controls and inhibits to contain laser beam or prevent inadvertent laser operation and/or crew exposure.
- ☐ c) Final list of crew protective equipment (goggles, etc,), if required hazard control.
- ☐ d) Test plan for verifying operating and transmission characteristics of laser (class 1M, 2M, 3R, 3B and 4 only)

9) Electrical Systems (Check List)

- ☐ a) Updated power distribution schematic(s) showing wire sizing and circuit protection.
- ☐ b) Updated bonding and grounding diagram.
- ☐ c) Updated diagrams for power distribution inhibits/controls for hazardous functions or controls.

10) Avionics Control (Check List)

- ☐ a) Updated schematics of safety-critical subsystems that indicate inhibits, controls, monitors.
- ☐ b) Verification approach (test pass/fail criteria) for each avionics leg of the hazard control/monitor subsystem, including test location procedures, and test apparatus used in substantiating end function.

11) Computer Systems (Check List)

Note
This section applies only to computer systems used to control hazardous functions.

- ☐ a) Describe the independence of computer and non-computer methods of hazard control and update block diagrams that detail the control of inhibits to a hazard.
- ☐ b) Update the description of computer system hazard controls, and the function(s) controlled by computer systems that prevent a hazard from occurring or control a hazardous function, including design features for computers controlling multiple inhibits to a hazard and designed to be greater than zero-fault tolerant.
- ☐ c) Summarize the functional testing of the software/hardware, and describe the verification approach for the computer based hazard control system.

12) Mechanisms in Critical Applications (Check List)

- ☐ a) Provide updates of critical procedures and processes to meet safety requirements using either a) failure tolerant approach or b) DFMR approach. Include fault-tolerance analysis for the safety-critical mechanisms explaining the independent success legs in place to meet fault-tolerance requirements and, if using DFMR approach, a completed matrix detailing how each requirement will be met for each mechanism relying upon a DFMR designation as a success leg.
- ☐ b) Include fault-tolerance analysis for the safety-critical mechanisms explaining the independent success legs in place to meet fault-tolerance requirements and, if using DFMR approach, a completed matrix, detailing how each requirement will be met for each mechanism relying upon a DFMR designation as a success leg.
- ☐ c) A complete discussion of the verification approach, including qualification and acceptance tests and analyses, for each critical mechanism operation or feature is required.
- ☐ d) Fracture control status (including parts categorization).

13) Batteries (Check List)

- ☐ a) Confirmed list of type and number of cells and batteries, cell/battery size (capacity),cell/battery voltage, battery configuration, cell/battery chemistry, cell/battery manufacturer, and model number(s) and charging circuit (if applicable), usage load and environment (including launch and return/landing vehicles).
- ☐ b) Electrical power diagram detailing cell/battery safety circuit diagram including charging circuit showing compliance with applicable technical requirements. Diagram of charging devices, characteristics, and implementation procedures. Confirmed design approach to fault tolerance or design for minimum risk strategy to meet battery safety requirements of JSC 20793, “Crewed Space Vehicle Battery Safety Requirements.”

- ☐ c) Charging characteristics and procedures, e.g., pulse charging, charge rate, trickle charge rate, and method of charge termination.
- ☐ d) Verification plan, including qualification, flight and acceptance tests and lot sample testing (where applicable).
- ☐ e) Fracture control approach for battery cells where leakage causes a catastrophic hazard and for nickel-hydrogen batteries. (Refer to paragraph for data submittal on fracture critical pressurized components or pressure vessels).

14) Sealed Containers (Check List)

- ☐ a) List the name of each sealed container and verify that information furnished at Phase I is still valid. If not, identify and explain changes.
- ☐ b) Provide preliminary summary of analyses and tests for each sealed container as required by pressure ratings and verification methods.

15) Biological Materials (Check List)

- ☐ a) Updated list of biological materials.

APPENDIX E
PHASE III TECHNICAL DATA SUBMITTAL

Hazard Report Support Data

1) Structures (Check List)

- ☐ a) Structural Verification Report that provides a summary of verification tests/analyses/inspections results.
- ☐ b) Fracture Control Summary Report (FCSR)
- ☐ c) Final identification of all materials, their intended use, configuration, and verification status to assure that the material failure will not result in a hazardous condition.
- ☐ d) Documentation of compliance with fastener integrity program.
- ☐ e) Final Loads Analysis Summary.

2) Pressure Systems (Check List)

- ☐ a) Final pressurized system schematic(s) and operating parameters, addressing all pressurized hardware.
- ☐ b) Final MDP derivation summary and table of pressurized system hardware, including the "Proof Factor (Maximum Test Pressure)" and "Leak rate method for hazardous materials".
- ☐ c) Final list of all system working fluids, their complete chemical composition, amounts, hazards and categories.
- ☐ d) Certification of pressure vessel(s) design, including qualification and acceptance test results.
- ☐ e) FCSR
- ☐ f) Final identification of all materials, their intended use, configuration, and verification status to assure that the material failure will not result in a hazardous condition.
- ☐ g) For safe life and limited life pressure vessels, document existence of a Pressure Log, including log number.
- ☐ h) Summary of results from verification tests/analyses/inspections for controls to ensure pressure integrity.
- ☐ i) For fluids whose leakage is hazardous also include: Summary of results from verification tests/analyses/inspections for controls to prevent leakage.
- ☐ j) For the DFMR approach to protect against leakage that may cause a catastrophic hazard include: 1) summary of results from certification tests and analyses on wetted mechanical fittings, 2) final list of system fusion joints and results from NDE. Final list of system bi-metallic joint(s), manufacturer(s) and certification data, 3) final list of wetted materials and their compatibility rating with system and cleaning fluids.

3) Pyrotechnic Devices (Check List)

- ☐ a) Summary of verification tests/analyses/inspections results.

4) Material Compatibility, Toxicity, Flammability, and Toxic Offgassing (Check List)

- ☐ a) Final list of toxic materials and their MSDSs.
- ☐ b) Final materials assessment.
- ☐ c) Final evaluation of materials compatibility with fluids

5) Ionizing Radiation (Check List)

- ☐ a) Updated list of all Ionizing Radiation Sources and include the following data for each source: 1) Type of material, 2) Amount of material, 3) Type and worst case intensity of the radiation given off of that source (α, β, γ), 4) Proposed use of that source, 5) Plan for providing shielding (if necessary), and 6) Identify whether or not a keep out zone is needed for that source.
- ☐ b) KSC Forms per KNPR 1860.1

6) Non-Ionizing Radiation (Check List)

- ☐ a) Final list of equipment that generates non-ionizing radiation, including actual nominal operational characteristics of all non-ionizing radiation sources.
- ☐ b) Submit final report of relevant EMI/EMC test results
- ☐ c) KSC Forms per KNPR 1860.2

7) Permanent Magnets (Check List)

- ☐ a) Final listing of all permanent magnets, quantity, and magnetic field intensity/values.

8) Non-Ionizing Radiation - Lasers (Check List)

- ☐ a) Summary of verifications and test results.

9) Electrical Systems (Check List)

- ☐ a) As-built power distribution schematic(s) that show wire sizing, circuit protection and bonding and grounding.
- ☐ b) Summary of verification tests/analyses/inspection results for bonding and grounding.
- ☐ c) Final diagrams for power distribution inhibits/controls for hazardous functions or controls.

10) Avionics Control (Check List)

- ☐ a) As-built schematics of safety-critical subsystems that indicate inhibits, controls, and monitors.
- ☐ b) Summary of test results and summary of test procedures, including hardware testing and/or fully integrated testing.

11) Computer Systems (Check List)

Note

This section applies only to computer systems used to control hazardous functions.

- ☐ a) Provide a summary of results of computer based hazard control verification activity, including summaries of any failures/errors of the baselined flight software used for hazard control.
- ☐ b) Update CBCS hazard control diagrams to show independence of inhibits, and provide verification details for CBCS that controls multiple inhibits to a hazardous function that confirms fault tolerance of CBCS and independence of inhibits.

12) Mechanisms in Critical Applications (Check List)

- ☐ a) Fracture control summary report (FCSR)
- ☐ b) MSVR
  1) Summary of the results of all verification testing, analyses, and inspections.
  2) Trade/special studies supporting HRs
  3) Flight HRs and appropriate support data
  4) A summary listing in the SDP description section of safety-critical services used to control and/or monitor hazards
- ☐ d) Completed functional verification matrix

13) Batteries (Check List)

- ☐ a) Final list of type and number of cells and batteries, cell size/battery size (capacity), battery configuration (series/parallel), cell/battery chemistry, cell manufacturer, and model number(s), usage loads and environment, details of application and launch and landing vehicles.
- ☐ b) Final circuit diagrams, including safety circuitry and charging circuit showing compliance with applicable safety requirements. Final design for fault tolerance controls or design for minimum risk strategy to meet battery safety requirements. See requirements in JSC 20793, "Crewed Space Vehicle Battery Safety Requirements."
- ☐ c) Final design details and a diagram for battery boxes that indicates materials of construction, absorbent material, venting provisions and other unique safety controls.

- ☐ d) Results of verification tests for qualification and flight acceptance tests, results of lot acceptance tests where applicable, analyses, and inspections.

14) Sealed Containers (Check List)

- ☐ a) List the name of each sealed container and verify that information furnished at Phase II is still valid. If not, identify and explain changes.
- ☐ b) Provide final identification of MDP, fluid(s), materials of construction for container enclosure, stored energy due to pressure, and environmental conditions.
- ☐ c) Provide final acceptance rationale for each sealed container including a summary of any required analyses and tests.

15) Biological Materials (Check List)

- ☐ a) Final list of biological materials.

APPENDIX F
STANDARDIZED HAZARD CONTROL REPORT FORMAT

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-*HAZARD REPORT NO?*	*PHASE?*	*DATE?*
D. HARDWARE NAME			
HARDWARE NAME?			
E. HARDWARE DESCRIPTION *(include part number(s), if applicable)*			

	HARDWARE ORGANIZATION APPROVAL	**SLS PAYLOAD SAFETY CONCURRENCE**
PHASE *PHASE?*	Project Manager _____ Date _____	SLS EM-1 PSRP Chair _____ Date _____ This hazard report has successfully completed the indicated SLS EM-1 PSRP phase review.

Signatures above are effective for all the following pages.

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*

D. HARDWARE NAME

HARDWARE NAME?

F. HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:** *(If Not Applicable for hardware, enter N/A and state why.)*
1) Payload Deployment **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) and b) in <u>all</u> cases. a) Be compatible with a minimum ejection rate of 4.6 ft/sec (1.4 m/sec) b) Restrict payload volume expansion of its launch configuration, which expands its size beyond 3 times its launch envelope, for a minimum of 15 seconds after deployment. For co-deployment payloads in addition to a) and b). c) Restricted to a 5 second delay between deployer activation.	☐ ☐ ☐	*Note: Identify the features used to restrict deployment in b) and c) as an attachment.*
2) Structural Failure **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) and b) in <u>all</u> cases. a) Mounted in an approved Payload Dispenser for launch. b) Payload primary structure designed to a FoS of 1.4 for the worst case environments for the MSA in SLS-SPIO-SPEC-001 "ISPE Design Environments Document".	☐ ☐	*Note: A non-approved Payload Dispenser will require a unique hazard report.* *Note: Identify the Payload Dispenser and provide a summary of the loads assessment as an attachment.*
3) Structural Failure of Sealed Containers **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Sealed containers must not have a window, must not be attached to hoses or lines, and must be compliant with a) and b) in <u>all</u> cases: a) Be a single, independent container containing a non-hazardous substance. b) Contain less than 19,310 Joules (14,240 foot-pounds) of stored energy due to pressure. AND c) Have a maximum delta pressure of 1.5 atmospheres (22 psia, 1.5 bars). OR d) Have an Maximum Design Pressure (MDP) greater than 1.5 atm (22 psia, 1.5 bars), but less than 6.81 atm (100 psia, 6.9 bars) <u>and</u> analysis or test showing minimum safety factor for the design is 2.5 X MDP. OR e) Have an MDP greater than 1.5 atm (22 psia, 1.5 bars), but less than 6.81 atm (100 psia, 6.9 bars) <u>and</u> each flight unit pass a proof test to 1.5 X MDP.	☐ ☐ ☐ ☐	*Note: Include a table of the sealed container(s) with the amount of stored energy and maximum pressure as an attachment.*

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PSRP PHASE	C. DATE
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*

D. HARDWARE NAME

HARDWARE NAME?

F. HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE AND STATUS: *(If Not Applicable for hardware, enter N/A and state why.)*
4) Structural Failure of Vented Containers **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Vented enclosures are not intentionally sealed and will not create a hazard during depressurization of the surrounding volume as verified by at least one of the following: a) Contain less than 4,152 J (3,063 ft-lbs) of stored energy due to pressure in the event of vent(s) failure *Note: Calculation of the stored energy potential can be found in NASA-HDBK-5010, Appendix. G* b) Vents are sized to maintain a minimum FoS of 1.4 for pressure loads when assessed against a depressurization rate of 0.15 psi/sec (9 psi/min). c) Provides an internal volume to effective vent area ratio that results in a differential pressure loading of no greater than 0.7 millibars differential (0.01 psid). *Note: Maximum Effective Vent Ratio (MEVR) for a 0.7 millibar (0.01 psid) pressure differential is defined as:* $MEVR = \left(\frac{Internal\ volume\ (cm^3)}{Effective\ vent\ area\ (cm^2)}\right) \leq 5080\ cm$ $MEVR = \left(\frac{Internal\ volume\ (in^3)}{Effective\ vent\ area\ (\ in^2)}\right) \leq 2000 in$	☐ ☐ ☐	*Note: Include a listing of the vented container(s) and analysis summary as an attachment.*
5) Materials - Biological **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) and b) in all cases. a) Biological material has a BSL ≤1. b) Containment is provided by a certified single level of containment.	☐ ☐	*Note: Provide data on biological material and rationale for BSL rating.* *Note: Reference data on containment (container or pressure vessel hazard report).*
6) Materials – Flammability **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Meets one or more of the following: a) A-rated materials selected from MAPTIS. b) Flammability assessment per NASA STD-6001B. c) Flammability testing per NASA STD-6001B.	☐ ☐ ☐	*Note: Include a material list as an attachment.*

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*

D. HARDWARE NAME

HARDWARE NAME?

F. HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:** *(If Not Applicable for hardware, enter N/A and state why.)*
7) Materials – Offgassing/ Outgassing **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Meets one or more of the following: a) Material evaluation per MAPTIS. OFFGASSING b) Offgassing tests of assembled article per NASA-STD-6001B. OUTGASSING c) Outgassing tests per ASTM-E595. d) Vacuum bake out per MSFC-SPEC-1238	☐ ☐ ☐	*Note: Include a material list as an attachment.*
8) Deployment Actuators **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) and either b) or c) in all cases: a) Uses NEA (Non Explosive Assembly) devices (no pyrotechnics). AND b) NEAs cannot be inadvertently operated. OR c) Inadvertent operation is not a hazard.	☐ ☐ ☐	*Note: Include system description, diagram, listing of NEAs, and assessment of inadvertent operation as an attachment.* *Note: NEAs that create a hazard and Pyrotechnics require a unique hazard report.*
9) Ionizing Radiation **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Source must be: a) considered non-hazardous to ground crews and to vehicle systems.	☐	*Note: Include listing of sources, descriptive data, and proposed use as an attachment.*

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*
D. HARDWARE NAME			
HARDWARE NAME?			

F. HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:** *(If Not Applicable for hardware, enter N/A and state why.)*
10) Electromagnetic Radiation (Non-Ionizing) causing interference with systems **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a), b), and c) in <u>all</u> cases. a) Remain powered off from the time of hand over for integration at KSC until deployment. b) Payload is not susceptible to the electronic emission environment documented in SLS-SPIO-SPEC-001 "ISPE Design Environments Document". The electronic emission environment shall not result in inadvertent operation of payload functions. c) Design meets the requirements for a Class S bond per NASA-STD-4003. For Transmitters d) Delay any signal transmissions for a minimum of 15 seconds after deployment. AND e) or f) e) Have one RF inhibit for power output < 1.5 W. f) Have two RF inhibits for power output ≥ 1.5 W.	☐ ☐ ☐ ☐ ☐ ☐	*Note: Include a description and diagram of power and RF inhibits as an attachment.*
11) Lasers causing injury to personnel **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	a) Lasers are powered off or are totally contained by the Payload for ground processing (no access). If accessed or powered during ground processing, meet all that apply: b) Classified as a Class 1 and/or Class 2 laser, as defined in ANSI Z136.1-2007 (as measured at the source). c) The radiant exposure, H, or irradiance, E, at a person's eye or on the skin for laser source shall not exceed the maximum permissible exposure (MPE) as defined in ANSI Z136.1-2007.	☐ ☐ ☐	*Note: For high intensity incoherent light use a unique hazard report.* *Note: Include a list of all lasers and their proposed use along with the manufacturer laser data sheet(s) as an attachment.* *Note: Lasers operating at class 1M, 2M, 3R, 3B and 4 meeting ANSI Z136.1 -2007 and ANSI Z136.4-2005 shall be documented on a unique hazard report.*

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*
D. HARDWARE NAME			
HARDWARE NAME?			

F. HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:** *(If Not Applicable for hardware, enter N/A and state why.)*
12) Electrical Power causing damage to electrical equipment **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) through d) in all cases. a) Remain powered off from the time of hand over for integration at KSC until deployment. b) Design meets circuit protection and wire sizing requirements for spacecraft. c) Design meets grounding requirements per interface requirements. d) Design meets the requirements for a Class S bond per NASA-STD-4003.	☐ ☐ ☐ ☐	*Note: Include a description and diagram of power inhibits as an attachment.* *Note: Include circuit protection, wire sizing, bonding and grounding diagrams as an attachment.*

SLS EM-1 SECONDARY PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	**A. NUMBER**	**B. PSRP PHASE**	**C. DATE**
	STD-HAZARD *REPORT NO?*	*PHASE?*	*DATE?*
D. HARDWARE NAME			
HARDWARE NAME?			

F. HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:** *(If Not Applicable for hardware, enter N/A and state why.)*
14) Ignition of Flammable Atmospheres **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Must be compliant with a) and b) in <u>all</u> cases. a) Remain powered off during ascent. b) Conductive surfaces (including metalized MLI layers) are electrostatically bonded per the requirements of a Class S bond as documented in NASA-STD-4003.	☐ ☐	*Note: Include a description and diagram of power inhibits as an attachment.*
15) Mechanical Hazards Causing Injury (sharp edges, burrs, etc.) **Mission Phase** ☐ **Ground Processing** ☐ **Flight**	Meet all that apply: a) Payload must be designed such that there are no sharp corners, edges, burrs, or pinch points. AND/OR b) Any surfaces that do not meet a) are inaccessible.	☐ ☐	

APPENDIX G
UNIQUE HAZARD CONTROL REPORT FORMAT

Payload Name
SLS EM-1 Secondary Payload
HR IDENTIFIER

1. HAZARD TITLE:
Enter a brief description of the hazard in terms of hazard initiator, action or consequence.

a. Review Level: *Phase I, II, or III*
b. Revision Date: *Date*
c. Scope: *Payload, Payload Carrier*
d. Hazard Report Focal: *Name, Phone Number*

2. HAZARD CONDITION DESCRIPTION:
The hazard description should define the risk situation including the unsafe act or conditions and its effect on SLS or personnel.

3. CAUSE SUMMARY:

CAUSE 1: *Cause Title 1*
SEVERITY: LIKELIHOOD:
CAUSE 2: *Cause Title 2*
SEVERITY: LIKELIHOOD:

4. INTERFACES:
What does the Payload interface with? Does it rely on other hardware for controls?

5. STATUS OF OPEN WORK:

CAUSE 1: Closed or Open (Phase II); Closed or Closed to SVTL (Phase III)
CAUSE 2: Closed or Open (Phase II); Closed or Closed to SVTL (Phase III)

6. REMARKS:
Entries here should include any information relating to the hazard but not fully covered in any other item field.

7. SUBMITTAL CONCURRENCE:

Payload Developer Safety Engineer	Date
Payload Developer S&MA Lead	Date
Payload Developer Chief Engineer	Date
Payload Developer Manager	Date
NASA Payload Safety Engineer (PSE)	Date
NASA Secondary Payload Integration Manager (SPIM)	Date
Payload Developer Safety Engineer	Date

8. CONCURRENCE (EM-1 Payload Safety Review Panel):

The signature below indicates that this hazard report has successfully completed the indicated SLS EM-1 PSRP review.

PSRP Phase:

Chairperson, SLS EM-1 PSRP	Date

HR IDENTIFIER
CAUSE #

9. HAZARD CAUSE DESCRIPTION:

Describe the types of phenomena that are of concern, i.e., the key factor to be assessed as leading to the expected outcome/consequence.

SEVERITY: LIKELIHOOD:

10. CONTROLS:

CONTROL 1: **a.** **b. c.**

Control text.

CONTROL 2: **d.** **e. f.**

Control text.

11. METHOD FOR VERIFICATION OF CONTROLS:

VERIFICATION FOR CONTROL 1:

1.1.1 *Verification Text.*
1.1.2 *Verification Text.*

STATUS OF VERIFICATION FOR CONTROL 1:

1.1.1 *CLOSED. Closure data summary.*
1.1.2 *CLOSED TO SVTL. Closure data summary.*

VERIFICATION FOR CONTROL 2:

1.2.1 *Verification Text.*
1.2.2 *Verification Text.*

STATUS OF VERIFICATION FOR CONTROL 2:

1.2.1 *CLOSED. Closure data summary.*
1.2.2 *CLOSED TO SVTL. Closure data summary.*

11. SAFETY REQUIREMENTS:

DOCUMENT: *Document Number*
TITLE: *Document Title*

Paragraph: *Paragraph No. Paragraph Title*
Paragraph No. Paragraph Title
Paragraph No. Paragraph Title
Paragraph No. Paragraph Title

12. MISSION PHASES: (MARK APPLICABLE PHASES)

_____ Ground Processing
_____ Flight

13. CAUSE REMARKS:

Entries should include any information relating to the hazard cause but not fully covered in any other item field.

14. POINT OF CONTACT:

Name *Title* *Phone Number*

Note: Repeat items #8 - #14 for each hazard cause.

Instructions for SLS EM-1 Secondary Payload Unique Hazard Report

Instructions for Top Level Pages

Payload Name

Project or Payload name.

Hazard Report Number

A unique alphanumeric designation provided by the payload organization or hardware developer that will be used to track this hazard report. These designations will be assigned when the report is first submitted and must be retained for all future updates of the hazard report. Generally, a payload such as the Multi-Purpose Logistics Module will use MPLM followed by a number to indicate which unique hazard is being referred to in a series or hazards reports.

Example: MPLM-01 or MPLM-001

1 Title

Enter a brief description of the hazard in terms of hazard initiator, action or consequence.

1a Review Level

Enter the milestone review the hazard report was written for (Phase I, Phase II, Phase III, etc.)

1b Date

Enter the date the hazard report was entered or revised.

1c Scope

Describe the scope of the hazards being addressed including, as appropriate, the end item, system, subsystem, and operation.

1d Hazard Report Focal

Name and phone number of the hazard report author.

2 Hazard Condition Description

The hazard description should define the risk situation including the unsafe act or conditions and its effect on SLS or personnel.

3 Cause Summary

List the titles of causes associated with this hazard along with the severity and likelihood of each cause.

4 Interfaces

Identify other hardware items that this payload interfaces with, particularly if the Payload relies on that interface for controls.

5 Status of Open Work

Indicate the verification status for each cause. (Phase II and III only) At Phase II, causes can be either open or closed. At Phase III, causes can be either closed or closed to SVTL (SVTL tracks open items from Phase III until flight).

6 Remarks

Entries here should include any information relating to the hazard but not fully covered in any other item field.

7 Submittal Concurrence

Project Signature indicates agreement with the content at the current phase or level of program maturity and accuracy. Include signatures from the safety engineer that prepared the hazard analysis, S&MA lead (if applicable), and lead or chief engineer.

8 PSRP Concurrence

The SLS EM-1 PSRP Chairman's signature indicates this hazard report has successfully completed the noted SLS EM-1 PSRP review.

Instructions for Each Cause Page

Hazard Report Number

From top page.

Cause Number

Indicates the cause number.

1 Hazard Cause Description

Describe the types of phenomena that are of concern, i.e., the key factor to be assessed as leading to the expected outcome/consequence.

Severity

This index quantifies the worst case accident or undesired event resulting from this cause. Severity levels are defined in ESD 10010.

Likelihood

The likelihood (probability of occurrence) of this hazard cause manifesting itself after controls have been implemented. Likelihood levels are defined in ESD 10010.

2 Controls

Provide a description of all the necessary design/operational controls needed to mitigate this hazard cause, including documentation references, if applicable. The control methods identify techniques which will be or are used to control or eliminate the hazard cause and thereby satisfy the Safety Requirement. Sufficient detail shall be provided to clearly reflect controls which mitigate/control the hazard. The hazard controls shall be numbered to provide linkages with Method of Verification of Controls.

3 Method for Verification of Controls(s)

Identify for each control method the method of verification (procedure/processes), including document number if applicable, used to assure the effectiveness of the hazard controls. Each control verification method must link with its corresponding control, and when more than one method of verification is listed for a control, the verification methods will be listed separately. Each verification method description shall include sufficient detail or explanation of the testing, inspection, analysis or procedure which mitigates the hazard to support hazard closure or risk acceptance.

Note: Verification status is not required until Phase III

4 Safety Requirement(s)

Identify the design requirements used this cause.

5 Mission Phase(s)

Identify the phase of the mission in which the hazard manifests itself. An (X) indicates that the identified phase is affected by the hazard. An (O) indicates that it has been considered but is not affected.

6 Cause Remarks

Entries here should include any information relating to the hazard cause but not fully covered in any other item field.

7 Point of Contact

Provide the name and telephone number of the individual to be used as a point of contact for this cause.

Attachments

As part of the hazard analysis, attachments are used to provide supporting data to the hazard analysis itself. An attachment will be provided directly behind the cause supported by that attachment. If that attachment is used by more than one cause, either place the attachment behind the top level pages or behind the first cause in which the attachment is referenced.

APPENDIX H
SLS EM-1 PSRP CERTIFICATE OF ENDORSEMENT

Certificate of Endorsement

SLS EM-1 Payload Safety Review Panel

Payload		
Phase III Review Date		
Hazard Reports Endorsed		
Document number	Title	Date
Hazard Reports Rejected		
Document number	Title	Date
Approved Waivers		
Waiver Number	Title	Date

Check one:

☐ Endorsement: By provisions of the signatures below, the SLS EM-1 Payload Safety Review Panel endorses the listed payload safety assessments and, that per the PSRP review, the payload meets the requirements of SLS-RQMT-216 and SLS-PLAN-217 and that shows an acceptable level of risk to SLS flight.

☐ Non-Endorsement: By provisions of the signatures below, the SLS EM-1 Payload Safety Review Panel does **NOT** endorses the listed payload safety assessments and, that per the PSRP review, the payload does **NOT** meet the requirements of SLS-RQMT-216 and SLS-PLAN-217 and / or that does **NOT** show an acceptable level of risk to SLS flight.

	Signature	**Date**
SLS EM-1 PSRP Chairperson		
SLS Engineering		
SLS Safety and Mission Assurance		
Flight Programs and Projects Directorate		

APPENDIX I
SVTL FORMAT AND INSTRUCTIONS

Instructions for the completion of the SLS EM-1 Secondary Payload Verification Tracking Log are as follows:

Payload

Payload name.

Date

Enter the date the SVTL was entered or revised.

Log Number

Use a unique identifier to track each verification item. The payload developer assigns these designations and includes them on the verification log included in the phase III safety data package.

Hazard Report Number

Indicate the number of the hazard report containing the verification item.

Verification Number

List the verification number from the Safety Verification Method block of the applicable hazard report.

Safety Verification

Transfer verbatim from the hazard report the safety verification method. Identify procedures by number and title from the hazard report.

Operations Constrained

Indicate what operations are constrained by the closure of this verification. Examples include but are not limited to (Shipment, Ground Processing, Launch, etc.) For example, if a verification has a "Shipment" constraint, then the Payload Developer would not be allowed to ship the hardware until the verification is closed. This is frequently the case for any of the qualification tests. In the case of verifications marked for ground processing, be specific about what ground operations are impacted. Verification that are marked for "Ground Processing" or "Launch" will have to be communicated to the appropriate groups.

Independent Verification Required?

Indicate whether or not (Y or N) this verification requires verification by an independent group such as DCMA or maybe a special organization at the launch site.

Scheduled Date

Indicate the date planned for completion of the verification.

Completion Date

Indicate the actual date of completion.

Method of Verification

Indicate by title and serial number the tests, inspections, analyses, etc. by which this verification will be formally closed and include any additional information or remarks.

SLS EM-1 Secondary Payloads Safety Verification Tracking Log

Payload: | Note: Items grayed out in the Status block are closed. | Date:

Log No.	HR No.	Ver. No.	Safety Verification (Identify Procedures By: Number and Title)	Operation(s) Constrained	Ind. Ver. Required?	Scheduled Date	Completion Date	Method of Closure Comments/Closure Summary
1								Data: Analysis (Inspection, Test, Ground Procedure?). Verification summary including test or analysis numbers. (Able to trace the information used to close the verification.)
2								
3								
4								
5								
6								
7								
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APPENDIX J
PAYLOAD DEVELOPER CERTIFICATE OF COMPLIANCE

PHASE III CERTIFICATE OF COMPLIANCE
SLS EM-1 SECONDARY PAYLOAD DEVELOPER

Payload		
Hazard Reports Submitted		
Document number	**Title**	**Date**
Waivers Submitted		
Waiver number	**Title**	**Date**

SLS EM-1 PSRP Phase III Certificate Statement

The Payload Developer hereby certifies that:

- The payload complies with all applicable requirements of SLS-RQMT-216, Space Launch System Program (SLSP) Exploration Mission-1 (EM-1) Safety Requirements for Secondary Payload Hardware and SLS-PLAN-217, Space Launch Systems Plan (SLSP) Exploration Mission -1 Secondary Payload Safety Review Process
- Safety waivers, as required, are processed and approved.
- The payload is safe to fly.

	Signature	**Date**
Payload Developer Manager		